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SCIENCE

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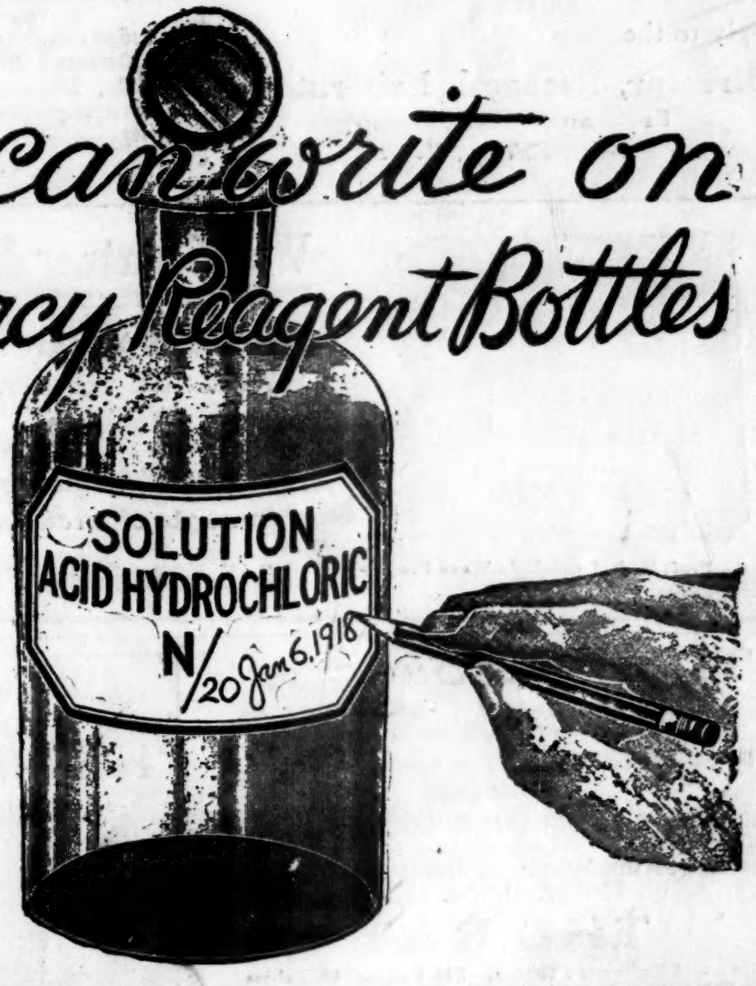

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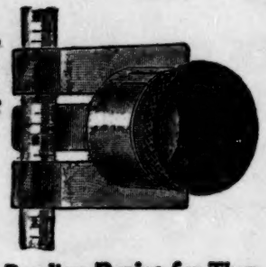

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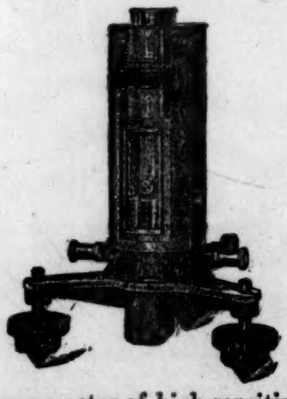

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SCIENCE

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CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to The Editor of Science, Garrison-on-Hudson, N. Y.

GROVE KARL GILBERT[1]

GROVE KARL GILBERT was one of the most eminent geologists of the world. As he was a native of Rochester and an honorary member of this society, the Academy of Science has special pride in his life and work.

Dr. Gilbert was born in Rochester, May 6, 1843. His father was the well-known portrait painter, Grove Sheldon Gilbert. For many years the family lived in the little house at the intersection of Culver Road and Merchants Road, but Karl was not born there. He had six brothers and sisters. The usual want of thrift and acquisitiveness in men of the artistic temperament held in the case of the father, and it appears that the family was poor and that Karl had to obtain some help for his course in college. He graduated as Bachelor of Arts at the university in 1862.

Following his graduation he taught for one year as principal of the schools in Jackson, Mich. He then returned to Rochester and until 1868 was assistant to Henry A. Ward. This work on the geologic and zoologic material of Ward's establishment probably determined his future scientific career. Many thousands of the labels in the University Geological Museum, which was the famous Ward collection, carry the pen-work of young Gilbert.

In 1869 he began, on the Ohio Geological Survey, under Professor J. S. Newberry, his geologic work. That this work was deliberate choice appears from the "Historical Sketch" by Newberry, in the report for 1869 (page 9), where we read:

> Of the other members of the corps, Messrs. Gilbert and Sherwood were geologists who had devoted much time to practical geology in New York and Pennsylvania, and who, for the purpose of adding to their experience, volunteered their serv-

[1] Memoir presented to the Rochester Academy of Science.

ices for no other compensation than their traveling expenses.

In the report for 1870 Dr. Newberry writes:

> The fossil fishes and fossil plants found in the state have been described by myself. They have been drawn by Mr. T. Y. Gardner and Mr. G. K. Gilbert in a style that has not been surpassed in this country, and some of their work is equal to any of a similar character done by the best European draughtsmen (page 8).

This volume contains a short report by Gilbert on three counties in the northwestern part of the state.[2] A fuller report on the same district is attached to a report on the surface geology of the Maumee Valley, found in Volume 1, of the final reports of the Newberry survey. This writing, published in 1873, contains six maps, evidently all his own work. The first two maps show the beaches of the ancient glacial waters in the Maumee Valley, and the correlation of the highest shore with the pass at Fort Wayne.

These fine maps are the first ever made in delineation of ancient lake beaches and correlation with the controlling outlet. The field work for this report was done in 1869 and 1870, when he was only twenty-seven years of age. At this time Gilbert did not recognize the receding ice sheet as the dam that held up the ancient waters, but he did clearly postulate deformation of the earth's surface as one cause of the variation of levels. He says (page 551):

> The more general conclusion that the system of raised beaches signify a succession of flexures of the earth's surface, rather than successive stages of subsidence due to the gradual removal of a barrier of tide water, or the gradual wear of a barrier of stone, does not rest on this single fact.

Even then he knew something of the change of levels in the Ontario basin, for he immediately says, in citing other similar facts: "There is evidence that Lake Ontario, at Rochester, N. Y., has stood 70 feet lower than it does now" (page 552). Some sentences in the same connection illustrate his capacity for generalization.

> While these facts abundantly prove that a simple theory of gradual drainage, by the elevation en masse of the lake regions, is entirely inadequate, they are too fragmentary to define clearly the general synchronism and sequence of the local movements to which they testify. Nevertheless, it is something to have learned that the writhing of the surface of the earth, which has in the ages so many times remapped the continents, has also been the great immediate cause of the transformations of the great lakes, and that, continuing through the latest distinguishable geological epoch and its prolongation the historical, it has now ceased.

Dr. Newberry was the first geologist to recognize the ice barrier as the cause of the high-level waters in the Laurentian basin, and it is interesting to find a footnote over his initials, at the bottom of the same page (552), reading as follows:

> In the discussion of these facts cited by Mr. Gilbert, and others of similar character, it should be remembered that the retreating glacier must have, for ages, constituted an ice dam that obstructed the natural lines of drainage, and may have maintained a high surface level in the water-basin which succeeded it.

The substance of Gilbert's report in the 1873 volume of the Ohio Survey had previous publication by permission in the *American Journal of Science* in 1871.[3] An abstract was also printed in the proceedings of the New York Academy of Sciences of February 20, 1871 (pp. 175–178).

In 1871 Gilbert joined the Wheeler survey of the western territories and began the many years of work in the far west. From 1875 he was on the survey under Major Powell. The United States Geological survey was organized in 1879, with Clarence King as director, and young Gilbert became a member. From that time to his death, May 1, 1918, he was continuously on the national survey.

Gilbert was not a prolific writer, as compared with others and judged by his work and ability. Down to 1891 the bibliographic list carries 70 titles, four of which have associated authors. His initial publication, in recognized geologic mediums, was in 1871, on the Cohoes mastodon in the twenty-first annual report of

[2] Part VII., pp. 485–499.

[3] Vol. 1 of third series, pp. 339–345.

the New York State Cabinet of Natural History. His next three articles have been noted above, relating to Ohio geology and the ancient beaches. From 1871 his papers are mostly in description of features of the western country. The most important of his earlier papers is the report on the Henry Mountains, published 1877. In this classic paper he described a new type of mountains, now fully recognized. These were originally domes, or areas of sedimentary strata lifted by the injection of lava from beneath. Quoting his own description, page 19:

> The lava of the Henry Mountains behaved differently. Instead of rising through all the beds of the earth's crust, it stopped at a lower horizon, insinuated itself between two strata, and opened for itself a chamber by lifting all the superior beds. In this chamber it congealed, forming a massive body of trap. For this body the name laccolite (cistern-stone) will be used.

In later years the name has been changed to laccolith. Subsequent erosion of these uplifts by doming has often destroyed the arching form or obscured the primitive shape and exposed the injected igneous heart. The latter part of this book is a discussion of land sculpture. In this statement of the principles of erosion and the origin of topographic forms he shares with Newberry and Powell the honor of a pioneer.

Probably his most famous writing is the work on Lake Bonneville. This is the initial volume of the series of quarto monographs published by the National Survey, and bears the date 1890. This describes the wide expanded predecessor of the present Great Salt Lake, which existed in glacial time when humidity and rainfall of the Great Basin produced the vast lake which overflowed northward to the Columbia River. Great Salt Lake is only the saline remnant of that desiccated fresh-water body.

This handsome quarto volume contains a chapter on "Topographic Features of Lake Shores" which is the classic writing on shoreline topography.

It is interesting to note that he published no articles relating to the Rochester region until after his long period of western exploration. His first publication in reference to the Ontario basin was in 1885, on the Iroquois shoreline; although he then called it simply the old shore-line of Ontario. Between then and 1891 he published six papers on the Pleistocene features or glacial history of the Ontario basin; and one on the sink ridges near Caledonia.

From 1892 to 1900, eight years, his list of writings is forty; covering a wide range of subjects in geology. Of these eight related to western New York. From 1901 to 1905 twenty-five titles are on record, of which only two concern western New York. During 1906 and 1907 he published nine articles, one being on Niagara. In 1908 only four articles, including another on Niagara, are recorded in the bibliography. Since 1908 only five titles are credited. Altogether this makes 156 titles, of which 18 relate to the geology of western New York or the Ontario basin.

The few papers published in later years is explained by his poor health, due to a slight stroke of apoplexy. After this time by very careful living he was able to do some work in a deliberate way. His latest study was the transportation of detritus by streams, with reference to hydraulic mining in California. This work, spread over several years, was published last year, being his last publication. It is entitled "Hydraulic-mining Debris in the Sierra Nevada," and is Professional Paper 105 of the Survey list, forming a quarto of 154 pages, with numerous maps and reproduction of photographs.

Dr. Gilbert's only writing for school textbooks in his "Introduction to Physical Geography," in collaboration with Professor A. P. Brigham. This was published in 1892 by D. Appleton and Company.

Geology is so broad and comprehensive and so inviting in many directions that some men with active minds and lively interest scatter their studies over diverse fields. Dr. Gilbert more wisely confined his work to physical geology, especially geodynamics, in which he was recognized as a master. He published practically nothing in biologic geology or paleontology; and almost nothing in stratigraphy and petrology.

His geologic interest in his home region was mainly in glacial problems, especially the glacial lake Iroquois and the deformation of the Ontario basin. He was the first geologist to appreciate the complexity of the Pleistocene history of the valley. As early as 1885 he recognized the three controlling factors: (*a*) the damming effect of the waning glacier and the glacial nature of the earlier waters; (*b*) the succession of water levels due to opening of different outlets or places of escape for the impounded waters, by the recession of the glacier front; and (*c*) the dislocation and canting of the water planes by the tilting uplift of the land. His accurate conclusions regarding the complex history are embodied in a number of short papers, and especially in a chapter in the "Sixth Annual Report of the Commissioners of the State Reservation at Niagara for the year 1890." The title of this important but little-known paper is "The History of Niagara."

Dr. Gilbert's mind was of the reflective, philosophic type. He sought for the explanation and relationship of phenomena. His calm judgment and clear discrimination joined to a spirit of fairness and with gentle manners caused him to be much sought as a critic and helper. He was a sort of father-adviser to the members of the survey. Doubtless much of his thought has found expression in the writings of the younger men who revered and loved him. The writer of this appreciation never heard him say a harsh word of any one. He was reserved in personal matters, but it is known that the death of a young daughter affected and saddened his life. His wife, who was Fannie L. Porter, died over twenty years ago. Two sons are living.

Dr. Gilbert received many honors. The University of Rochester gave him the master's degree in 1872, and the LL.D. degree in 1898. The latter degree was also conferred by the University of Wisconsin. He was the fourth president of the Geological Society of America, in 1892, and was again president in 1909, the only man honored by a second term. In 1899 he was president of the American Association for the Advancement of Science, probably the highest honor in the gift of American science. Naturally he was active and prominent in the scientific societies of the national capitol, and was a member of the National Academy of Sciences. He was one of the very few honorary members of this society. In 1892, when the American Association for the Advancement of Science held its annual meeting in Rochester, this academy held a special meeting in Music Hall complimentary to the association, and the lecture of the evening was given by Gilbert, the subject being: "Coon Butte and the Theories of Its Origin." The relief map which he used on that occasion was donated to the university museum. It may be said that this was one of the very few times in which his theory has been proven wrong.

On the approach of his seventy-fifth anniversary, the sixth of last May, his friends were asked to send to the Survey letters of appreciation to be handed to him on that day. Unhappily he passed away on the first of the month at Jackson, Mich.

Herman Leroy Fairchild

WAR BREAD

Dr. Alonzo E. Taylor in his book "War Bread" gives a large amount of valuable information concerning the conservation of wheat under war conditions. Our duty is plainly set forth and many helpful suggestions are made.

There are two topics discussed in this book, "Food Value of the Different Grains," and "Ways of Stretching Wheat," which are of particular interest to the student of nutrition. Briefly stated, Dr. Taylor's conclusions are that the direct substitution of other cereals for wheat, and the judicious use of mixed flours, are the best ways of conserving wheat. Long extraction flours milled so as to include the germ or bran have not proved satisfactory for the making of war bread. A few quotations will perhaps best serve to give the author's conclusions upon these points.

Direct substitution offers the most obvious way of saving wheat (p. 62).

The best mixed-flour bread is prepared from flour of standard extraction. For practical pur-

poses it does not make much difference what the diluting flour is (p. 69).

In comparing American and European extractions, the water content of flours must be kept in mind. Here the flour contains about 13 per cent. of water, in Europe higher water content is permitted, 17 per cent. being common. In other words, our 75 per cent. extraction corresponds to a 78 per cent. extraction in Europe (p. 76).

The germ contains both ferments and bacteria, and is, therefore, prone to decomposition. The ferments split the fats, making them rancid. They act upon the protein also. Aided by bacteria, they produce the musty decomposition that is liable to occur in coarse flours, and does not occur in standard flours under the same circumstances (p. 77).

The common experience with whole wheat flour is that it spoils rapidly, even in the hands of the trade; and this is one reason why whole wheat flours are expensive (p. 81).

Breads made from flours containing the endosperm and the germ fraction are not unusually good breads. The writer has eaten breads baked from flours of 81, 85, 88, 93 and 97 per cent. extraction in Germany, England and France[1] (p. 82). European bakers have worked for over two years to produce good breads from these flours. It has not been routinely accomplished in any country. The methods of bread baking are very different in France, Italy, Germany and England. The standards of what constitutes good bread and the tastes of the public are different. In not one of these countries have the bakers been able to meet the tastes of the consuming classes with breads made from flours containing the endosperm and the germ fraction. The loaf is smaller, the moisture content higher, often tending to sogginess, does not crust well, and remains, when all is said and done, an unsatisfactory bread. The revulsion against this bread has been audible in every country, the people have repeatedly petitioned that they be given less bread and better bread (p. 83).

It has been the experience in the European countries that breads prepared from higher extraction flours do not agree with many individuals. This holds as true of breads made from the 85 per cent. extraction as from the 93 per cent. extraction. Many children and adults fail to digest these breads. The result is discomfort and often colic, gaseous fermentation, and resultant disturbances of intestinal functions (p. 84).

It is the experience of the nations at war in Europe that they would abandon higher extraction and return to mixed flours, prepared from standard flour, provided this were possible. Breads made in England of Standard American flour diluted with an admixing flour are much better than straight breads of 85 per cent. extraction flour. The Victory Bread of the United States is so superior to the war bread of the Allies and of the enemies as to be past comparison (p. 86).

[1] Note as Dr. Taylor explains, 81 European extraction would be 78 American basis.

Dr. Taylor discusses, in a broad way, the mineral and vitamine contents of whole wheat and standard flours. He recognizes the common deficiency of all cereals in failing to supply certain fat soluble constituents which can be secured only through foods like milk, meat and leaf vegetables, and hence he can see no gain in the substitution of whole wheat for standard extraction flour. He says:

> In the diet of the nations at war there is a profusion of vegetables, more than in peace time, that contain minerals, roughage and vitamines freely. Go where one will, in the United Kingdom, France, Germany, Switzerland or Holland, one finds the diet of the people to-day rougher, coarser and containing more vegetables and less concentrated food stuffs than in peace time (pp. 87–88).

Under these circumstances, the plea for whole wheat flour in the American diet to-day fails of justification from this point of view. People should be allowed to select their roughage, whether in the form of fruits or vegetables, or in the form of whole grains. They should be allowed to select their mineral salts and vitamines in the same manner, and both are freely available. The legal distinction between food conservation and health propaganda must be kept in mind. It is argued in favor of whole wheat flour that its use might relieve or prevent constipation, rickets, scurvy, anaemia and pellagra. But the function of a food administration is to secure and conserve food, not treat preexisting diseases in a compulsory manner, applied to the majority who are not afflicted, as well as to the minority who may be diseased but still possess the right to select their treatment. In each country at war diet fads are being pushed at the food administration, who must confine themselves to the specific functions defined by legislative authorization (pp. 89–90).

As Dr. Taylor is a member of the U. S. Food Administration, and of the War Trade Board, Washington, naturally any statements which he publishes, particularly at this time, are of

more than momentary interest. The book is dedicated to Herbert Clark Hoover in the hope that it may aid his fellow citizens to support him.

HARRY SNYDER

THE BOTANY AND PLANT PRODUCTS OF NORTHERN SOUTH AMERICA

A COOPERATIVE investigation of the flora of northern South America, which, when carried out in detail, should be of highly significant scientific and economic importance, has recently been organized by the New York Botanical Garden, the United States National Museum, and the Gray Herbarium of Harvard University. This investigation is planned to include the plants inhabiting the Guianas, Venezuela, Colombia, Ecuador, and the adjacent Caribbean islands, Trinidad, Tobago, Margarita, Bonaire, Curaçao and Aruba.

The immediate object is to secure and organize collections of size and excellence from as many different floral areas as may be found feasible; to assemble all knowledge obtainable relative to the distribution of the species, their habitats, and their uses; and thus to acquire in North America, materials for critical investigations leading to much needed monographs of important groups and to detailed catalogues of floras as yet very inadequately known.

The region contemplated has great diversity of climate, soil and altitude and a corresponding wealth of vegetation. Perhaps no area of greater botanical promise has thus far received less organized floral investigation. Nor have the scattered results obtained in the past ever been brought together into correlated or accessible form, being at present scattered in fragmentary publications, foreign journals and casual works of travel, with the result that information even in regard to many plants of considerable economic promise is excessively difficult to assemble and surprisingly scanty when obtained.

In this rich and varied flora of northern South America is sure to be found a wealth of plants capable of yielding commercial timbers, drugs, vegetable oils, tannin, gums, waxes and essences of technical value, dye-stuffs, food-materials, fibers and countless substances such as rubber, highly significant in manufactures. Many of these products are reaching our markets in mixed or imperfect condition owing to inadequate knowledge of the precise plants from which they should be obtained. In other instances, although the species may be known, the range and availability is still too obscure to encourage enterprises of exploitation.

Recent events have shown how suddenly and unexpectedly America may be cut off from many European sources of manufacture and information. It is increasingly evident that all the American countries should gain the manufacturing and commercial independence which may be derived from a thorough scientific investigation of their natural resources. Among these the tropical American vegetation is one of the most significant and merits much more earnest investigation than it has thus far received.

It is confidently believed that the proposed studies will do much to extend the knowledge of South American products, and thus to increase trade and conduce to friendly relations with the countries concerned.

In the realm of pure science the results obtained will also have very important bearings on the studies of Central American vegetation already prosecuted by the National Museum and by the Gray Herbarium, and on those of the West Indian flora conducted by the New York Botanical Garden.

The scientists in charge of the botanical collections of the three cooperating institutions and other botanists and economists have long known the need for organized information relative to the vegetation of northern South America; these collections already contain specimens derived from various sources in the past, representing a considerable proportion of the plants inhabiting the region, and of their products, but much of this material has not been critically studied nor determined botanically. Old World museums and herbaria contain a more complete and better studied representation than American institutions possess. The extensive literature of the sub-

ject is, however, measurably complete in our libraries, but scattered under many hundred titles, mostly by European authors.

The investigation is primarily planned along the following lines:

1. The study, naming and cataloguing of specimens already in the three institutions. This work will incidentally much increase the reference strength of our herbaria and museums.

2. The increase of the three collections by specimens obtained through field expeditions sent to parts of the area as yet little known botanically, or in search of species of other areas as yet incompletely understood. Duplicate specimens beyond the three sets required will be distributed to other institutions in exchange. Friends of the institutions may furnish important aid by sending funds to any of them for the expenses of field expeditions.

3. The publication of advanced papers from time to time, dealing with portions of the investigation on which results have been reached, without awaiting the completion of the annotated catalogue.

The cooperative effort includes the following methods:

1. The subdivision of the work among staff members of the three institutions and among specialists of other institutions.

2. The loan of specimens from the collections of the three institutions to each other.

3. Visits of staff members of the three institutions to each other for the study of collections and for consultation.

4. Collections made by any of the institutions to be shared with the others.

5. Joint support of some of the field expeditions and division of the collections made.

Recent collections, the study of which has led up to the cooperative arrangement, include principally those made for the United States National Museum by H. Pittier in Venezuela in 1913; for the Gray Herbarium by J. A. Samuels in Dutch Guiana in 1916, and by H. A. Curran and M. Haman in Curaçao, Aruba, and northern Venezuela in 1917; and for the New York Botanical Garden by H. H. Rusby and F. W. Pennell in 1917 and 1918. The arrangement was consummated through correspondence between Dr. B. L. Robinson, of the Gray Herbarium, and Mr. Frederick V. Coville and Dr. J. N. Rose, of the National Museum, with Dr. N. L. Britton, of the New York Botanical Garden, in the latter part of 1917 and early in 1918, and it has been approved by the governing bodies and officials of the three institutions.

Professor Oakes Ames, of the Bussey Institution of Harvard University, has offered cooperation which has been gratefully accepted.

The first field expedition organized is one to Ecuador, led by Dr. J. N. Rose, of the United States National Museum; in this, the cooperating institutions are very materially aided by the Bureau of Plant Industry of the United States Department of Agriculture, the bureau desiring first-hand information about important economic plants which can be obtained only by field observations of a trained botanist. Dr. Rose left Washington on July 22, for an absence of about four months, and it is anticipated that the results of this work will add greatly to our knowledge of the flora and plant products of Ecuador.

The very large collections made by Drs. Rusby and Pennell in Colombia for the New York Botanical Garden are being organized for critical study, and will be divided among the three institutions as soon as possible.

SCIENTIFIC EVENTS

THE INTER-ALLIED FOOD COMMISSION

THE arrival of experts representing the allies to consider the food problem was announced in a previous issue. According to the *Journal* of the American Medical Association the Inter-Allied Food Commission meeting in London has decided that the minimal food requirements of "the average man" (weighing 154 pounds) doing average work during eight hours a day represent an energy value of 3,300 calories daily. In case it should become impossible to supply this requisite amount of food, a reduction of 10 per cent. on the foregoing figure can be supported for some time without injury to health. The commission agreed to accept Lusk's figures as to the pro-

portion of this amount to be assigned to women and to children of different ages. The following conclusions have been agreed on: (1) To state the weights of the various foods produced in each Allied country in metric tons. (2) It is not desirable to fix a minimal meat ration in view of the fact that no absolute physiologic need exists for meat, since the proteins of meat can be replaced by proteins of animal origin, such as those contained in milk, cheese and eggs, as well as by proteins of vegetable origin. The commission, on the other hand, resolved to fix a desirable minimal ration of fat—75 gm. per average man per day. The ration will be made up of (*a*) fats of vegetable origin and (*b*) fats of animal origin. If the amount of fats of vegetable origin are insufficient for this purpose, it may be necessary to maintain a certain stock of animals to furnish this fat. (3) The commission established the "man value," that is, the number of average men equivalent to the population of each of the Allied countries. This "man value" is taken as the basis for calculating the exact amount of food which must be provided for the adequate nourishment of the total population of each country. (4) The commission considered the estimates in tons of the home productions of the soil furnished by each Allied country for the year 1918–1919. These statistics will serve as a basis for determining the amount of food available for men and for animals, respectively, in each country. (5) Each delegation, in calculating the amount of calories available for men, should assign to men the maximal possible proportion of all cereals, excepts oats. (6) A uniform average milling extraction of 85 per cent. for wheat should be adopted throughout the Allied countries. This extraction may vary from 80 per cent. in summer to 90 per cent. in winter, and it can apply to the United States only as regards their internal consumption, and then only in case of scarcity. (7) The methods of reserving the maximal possible proportion of the cereal production for the use of man may vary in each country. Man should always take precedence over animals in the allocation of food. If this principle be accepted in the fixing of prices, it is the prices of animal products which should be limited, rather than those of such vegetable products of the soil as may serve equally well for feeding men and animals. Thus the production of veal, pork and poultry at the expense of food available for man should be discouraged, and this is best achieved by fixing a price for those animal products which will make it unprofitable for the producer to feed them on cereals. (8) The commission reserved for its next meeting the task of examining the figures which will enable it to determine the caloric value of the home production of each of the Allied countries. The determination of this figure, compared with the needs in calories of the population of each country, will enable the commission to deduce the amount of imports necessary for the maintenance of the population or the exportable surplus, as the case may be. (9) In all the Allied countries, any propaganda, having for its object the encouragement of food production and of economy in the use of food, should be organized and directed by men of science well acquainted with the subject.

FOURTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES

The Fourth National Exposition of Chemical Industries will be held in the Grand Central Palace, New York City, during the week of September 23 this year. The managers are Charles F. Roth and F. W. Payne. The advisory committee consists of Charles H. Herty, *chairman,* Raymond F. Bacon, L. H. Baekeland, Henry B. Faber, Ellwood Hendrick, Bernhard C. Hesse, A. D. Little, Wm. H. Nichols, H. C. Parmelee, R. P. Perry, G. W. Thompson, F. J. Tone, T. B. Wagner and M. C. Whitaker.

The *Journal of Industrial and Engineering Chemistry* says that the exposition is a wartime necessity and, regarding it as such, each exhibitor is planning his exhibit to be of the greatest benefit to the country through the men who visit it, all of whom are bent upon a serious purpose—that of producing war materials in large quantities and constantly in-

creasing this production until the war has been won by the United States and its Allies.

The managers report that the amount of floor space already engaged is greater than last year, that the exhibits will be much more attractive, and that a movement is under way to show all exhibits of machinery in operation under actual working conditions as they would be found in the plants.

Some sections of the south are again sending exhibits, and Canada is taking the opportunity of presenting the materials it has available for development by the chemist and financier. A section for the Glass and Ceramic Industry has been added with which the American Ceramic Society is cooperating.

The program for the Exposition is in active preparation. Opening addresses will be made by Dr. Charles H. Herty, chairman of the advisory committee, and Dr. G. W. Thompson, president of the American Institute of Chemical Engineers. There will be a series of symposiums on "The Development of Chemical Industries in the United States, notably since July, 1914." This will embrace the period since the beginning of the European War, which, by removing the source of supply for our domestic industries, inspired the development of our own chemical industries which, now that we ourselves have entered the war, are proving so effective. The subjects to be discussed are Potash Development, Chemical Engineering, Acids, Industrial Organic Chemistry, the Ceramic Industries and the Metal Industries Among the speakers will be:

C. A. Higgins, "Recovery of potash from kelp."
Linn Bradley, "Recovery of potash from cement dust and other sources by electrical precipitation."
A. Hough, "Chemical engineering in explosives; T. N. T., T. N. A., picric acid and nitrobenzol."
E. J. Pranke, "Development of nitric acid manufacture."
S. P. Sadtler, "Development of industrial organic chemistry."
George H. Tomlinson, "Wood as a source of ethyl alcohol."
C. A. Higgins, "Kelp as a source of organic solvents."
Alcan Hirsch, "Pyrophoric alloys."
Joseph W. Richards, "The ferro-alloys of silicon, tungsten, uranium, vanadium, molybenum, titanium."
Theodore Swann, "Ferromanganese."
Leonard Waldo, "The development of the magnesium industry."

The American Ceramic Society, which will hold its meeting at the Exposition on Thursday afternoon, September 26, has already upon its program:

A. V. Bleininger, "Recent developments in the ceramic industries."
L. E. Barringer, "Manufacture of electrical porcelain" (illustrated).
H. Ries, "American clays."
F. A. Whitaker, "Manufacture of stoneware" (illustrated).

Following this meeting a series of motion pictures of the ceramic industries will be shown.

The motion picture program, in the arrangement of which the Bureau of Commercial Economics is again cooperating, carries forward the idea of the symposiums, the pictures appropriate to a subject being shown on the same day as the symposium on that subject is held.

NUTRITION OFFICERS STATIONED IN THE CAMPS[1]

NUTRITION officers are to be stationed in every National Army cantonment and every National Guard camp, as well as in every camp where 10,000 or more soldiers are in training. These officers are food specialists who before they joined the army as members of the division of food and nutrition of the Medical Department were connected with colleges and public bodies as physiologists, chemists, economists, food inspectors and experts in other specialized work relating to food.

Since October of last year the division of food and nutrition has been making surveys of food conditions in the camps. Groups of officers have gone from camp to camp, studied the food served, how it was inspected, stored, and prepared, and have made recommenda-

[1] Statement from the office of the Surgeon General authorized by the War Department.

tions which, upon being carried out, resulted in many advantageous changes.

Although the principal work of these groups was inspection of the manner of handling and preparing food, the visiting officers were able to give considerable instruction in the principles of nutrition, the proper selection of foods, and the construction of dietaries to mess officers, medical officers and others who were interested. Detailed personal instruction was given to the mess personnel on some of these topics, as well as on the various methods of avoiding waste, the importance of keeping kitchens and mess halls clean and orderly, and the methods of judging and storing food.

Survey parties were instructed to seek in every possible way to reduce waste. It was found that men and officers were very willing to cooperate in making surveys and to reduce as much as possible the waste of food. One of the most effective means adopted for this purpose was introduced at one camp and followed later at other camps.

At this camp seven companies were selected from various organizations, totaling 1,135 men. A two-day survey was run on each mess, and the average edible waste was found to be 1.12 pounds per man per day. Instructions were then given to the mess sergeants and cooks in matters of food and mess economy, and when the officer in charge was satisfied that they had a reasonable understanding of the subject a second two-day survey was made. This showed an average edible waste of 0.43 pound per man per day—a saving of 0.69 pound. This saving amounted to $61.75 per day for the seven messes, or at the same rate would amount to $22,542 per year. If the same rate of saving were brought about for the entire camp, in this case approximately 15,000 men, it would amount to $338,000 a year.

Work of this character showed the necessity of keeping a nutrition officer in each camp at all times so that he might advise about the composition and nutritive value of dietaries, make inspections for adulterations, spoilage, and deterioration, and to cooperate with the mess officials.

Sixty new officers are to be commissioned in the division of food and nutrition to handle the additional work. All will be food specialists similar to those already in the service.

GREETINGS TO FRANCE FROM BRITISH SOCITIES

Messages to France on the occasion of France's day have been dispatched by all the leading societies and institutions in Great Britain, including the following scientific societies:

British Association.—Nineteen years ago the Dover meeting of the British Association was "so arranged that the two great nations which had been, a century earlier, grappling in a fierce struggle should in the persons of their men of science draw as near together as they could." Another joint meeting with France was on the point of taking place when our high hopes of lasting general peace were so cruelly destroyed. But out of the destruction has arisen a far closer union of our two peoples, and an even brighter prospect of our future cooperation for the good of humanity and science.

Royal Society.—The Royal Society of London sends greetings to the French nation and more especially to its scientific men. It recalls the intimate friendship which since their foundation has bound together the Académie des Sciences with its own body. Always united in their endeavor to promote the advance of science, they are now joined in their efforts to defend the cause of civilization and freedom.

British Academy.—To France, who has so often inspired and led civilization in Europe; to France, who upholds the banner of intellectual freedom and unfettered thought; to France, who for nearly four years has endured brutal outrage and the violation of all decencies of humanity and civilization, the British Academy, in the name of British scholarship, sends on this great anniversary a renewed assurance of loyal fraternity and of unshaken determination to continue the conflict until liberty is secured and French soil delivered from the desecration of the invader.

Royal College of Surgeons of England.—Brothers-in-Arms, we greet you. Bound by ancient ties of blood and by the memories of many a gallant contest in the past, to-day we stand as one nation united in a sacred cause. We have before us a happy presage from the past. As the united efforts of Pasteur and Lister have laid low the tyranny of disease, so shall France and Britain

conquer a tyranny still more remorseless. Our future brightens, and shall endow Gaul and Briton with a common birthright to remain a splendid heritage for all time.

SCIENTIFIC NOTES AND NEWS

THE hundredth annual meeting of the Swiss Association for the Natural Sciences will be held at Lugano from September 7 to 11. The committee on organization states that the continuation of the meetings is of value equally to science and to the country. Public lectures will be given as follows: Parthenogenesis and apogamy, by Professor Ernst, of Zurich; The Swiss national parks, by Professor Schroeter, of Zurich; Man from the point of view of medicine and natural science, by Professor Nägeli, of Zurich; On the constitution of the chemical elements, by Professor Berthoud, of Neuchâtel. The association meets in twelve sections: (1) Mathematics; (2) Physics; (3) Geophysics, Meteorology and Astronomy; (4) Chemistry; (5) Geology; (6) Botany; (7) Zoology; (8) Entomology; (9) Medicine; (10) Pharmacy; (11) Engineering; (12) Agriculture, Forestry and Fisheries.

DR. SAMUEL AVERY, formerly director of the chemical laboratories in the University of Nebraska, and for several years chancellor of that institution, has been commissioned major in the Chemical Warfare Service, N. A., and placed in charge of the University Relations Section. Dr. Avery has been granted a leave of absence by the regents of the university for the period of the war.

COLONEL JOHN M. T. FINNEY, chief surgical consultant of the American Expeditionary Forces, has returned home on a mission connected with his work overseas.

PROFESSOR E. C. FRANKLIN, of Stanford University, Professor W. J. A. Bliss, of Johns Hopkins University, and Professor C. M. Carson, of the Michigan School of Mines, are engaged for the summer on military work in the Chemistry Division of the Bureau of Standards.

DR. W. R. DODSON, dean of the college of agriculture of the University of Louisiana, and E. S. Brigham, commissioner of dairying of Vermont, have become members of the Food Administration staff in Washington. Dr. Dodson has charge of problems of interest to both the Food Administration and the Department of Agriculture. Mr. Brigham will head the butter and cheese section. Dean H. L. Russell, of the College of Agriculture of the University of Wisconsin, who has rendered service to the Food Administration in the capacities which Dr. Dodson and Mr. Brigham now assume, has been recalled to Wisconsin by pressing duties at the university.

DR. WILLIAM C. FOWLER has assumed office as health officer of the District of Columbia, succeeding Dr. William C. Woodward, who resigned to accept the position of commissioner of health of Boston.

DR. J. N. LANGLEY, professor of physiology in the University of Cambridge, Sir F. W. Dyson, astronomer royal, Dr. Horace Lamb, professor of mathematics in the University of Manchester, and Sir E. Rutherford, Langworthy professor and director of physical laboratories in the University of Manchester, have been elected foreign members of the Royal Academy "dei Lincei," Rome.

DR. BARTON WARREN EVERMANN, director of the museum, Dr. John Van Denburgh, curator of the department of herpetology, and Mr. Joseph R. Slevin, assistant curator, department of herpetology of the California Academy of Sciences, have returned from a collecting trip through northern California and southern Oregon. The principal object of the trip was to make collections of reptiles, amphibians, and birds' nests and eggs for the academy museum. The trip was made by machine and the party camped out most of the time. Very large collections were obtained.

MR. E. P. VAN DUZEE, curator department of entomology of the California Academy of Sciences, is spending the summer in northern California making collections for that department. Dr. Roy E. Dickerson, curator, department of invertebrate paleontology, has been given leave for the remainder of the present calendar year in order that he may take up

certain technical work for the Standard Oil Company.

The memorial statue of the late Dr. Edward A. Trudeau, founder of the Adirondack Cottage Sanatorium, now known as the Trudeau Sanatorium, Saranac, was unveiled on August 10. The principal oration was made by the Rev. Philemon F. Sturgis. The statue is a gift of former patients of the sanatorium, and bears an inscription indicative of the love and gratitude of the donors.

Henry George Plimmer, F.R.S., professor of comparative pathology in the Imperial College of Science and Technology, London, died on June 22, aged sixty-one years.

Dr. Newell Arber, demonstrator in paleobotany at Cambridge, died on June 14 at the age of forty-seven years.

The deaths are announced of A. Kolisko, of Vienna, professor of pathologic anatomy, and of Leopold Meyer, professor of the diseases of women and children, of the University of Copenhagen.

It is reported that one of the most complete hospitals in the world, expected to take a large part of the work of rehabilitating American soldiers wounded overseas, is being erected in Detroit by Henry Ford at a cost of three million dollars. The hospital is being built on a twenty-acre tract of land and will have a floor space of 50,000 square feet. It will be a four-story structure, with the exception of the diagnostic building placed in the center, which will be six stories high. There will be 1,300 windows in the building, 40 porches around it, and a roof garden.

By the will of a Mr. Ramsay, resident in Scotland, but who formerly had large financial interests in Toronto, the hospitals in Toronto and other public charities in that city will benefit to the extent of $750,000.

McGill University Hospital, at Etaples, France, is to be removed to England, as it has been bombed from German airplanes on several occasions.

The War Department authorizes the statement from the Office of the Surgeon General that, at the request of General Pershing, twenty additional nutrition officers have gone to Europe to supervise rationing of the soldiers of the American Expeditionary Forces and to introduce methods that will further protect the food of the troops from waste, spoilage and contamination. This brings the total of such officers now on duty in England and France to twenty-nine. The first six of these specialists went abroad in March. Their work was so satisfactory that in a few weeks more were asked for. The investigations made by these men resulted in improved mess conditions, both in camp and in the trenches, and demonstrated the necessity for continuous supervision, hence the recent sailing of the twenty. One of the principal problems facing these men is the adjusting of the present garrison ration to current needs. This ration was fixed long before the present conditions of modern warfare, and experience has shown that adjustments must be made in order to feed the troops satisfactorily without waste or spoilage.

The *Journal* of the American Medical Association states that the leading physicians of São Paulo have organized a society to study questions of heredity and means to improve the human race. Its aims and purposes are set forth in an eight-page pamphlet, especially emphasizing the aim to enlighten and educate the public in matters relating to hygiene and eugenics, for the welfare of the individual, of the community and of future generations.

The *Royal Geographical Journal* states that M. René de Saussure, great-grandson of the celebrated Swiss naturalist, outlines in the March, 1918, number of the *Archives des Sciences physiques et naturelles* of Geneva, a scheme for a Central Meteorological Bureau for Europe to be established after the war. He suggests that the time is opportune for the foundation of such a bureau, as it would enable the heads of the national meteorological services of belligerent countries to exchange necessary data without direct correspondence. But as he acknowledges that such a central bureau must be under the control of an international committee, this point loses its force, since such a committee must meet before the

bureau can be established. Until the future of the International Meteorological Committee, which has done good work for a generation past, is settled it is quite clear that no step of the kind suggested can profitably be considered. M. de Saussure estimates the annual cost of a central bureau charged with receiving data from stations in all parts of Europe, preparing a daily weather-map, forwarding it by post and telegraphing the data for a provisional map daily, at only 48,000 francs, or less than £2,000. We are sure that such a sum would be totally inadequate for the purpose, even if the bureau were situated, as is suggested, in Switzerland. The greater part of M. de Saussure's paper is taken up with the description of a new method of representing air-movement on maps which he thinks might be adopted in the work of the projected bureau.

THE council of the Society for Practical Astronomy have notified the members and those interested in its work that, by a vote of the council, all further activity of the society, including the publication of the *Monthly Register,* is postponed until after the war. No new members will be admitted, and membership fees for the current year, 1918, will be refunded by the treasurer. Upon resumption of activities, the organization of the society will be the same as it was at the close of 1917, the membership consisting of those who were members in good standing at that time. This decision has been reached after careful deliberation, and in spite of the example set by the scientific societies of our allies. The council feel confident that this step will meet with the unanimous approval of the members. Communications relative to any society matters, and particularly those concerning improvements in reorganization after the war, will be welcomed, and may be addressed to the president, Mr. Latimer J. Wilson, Bausch & Lomb Observatory, Huntington Park, near St. Paul St., Rochester, N. Y., or to the secretary, Lieutenant Horace C. Levinson, 4049 Lake Park Ave., Chicago, Ill.

THE sundry civil appropriation bill, carrying appropriations for the Bureau of Fisheries, became a law on July 1. The principal features of special interest are as follows: *New positions:* One field assistant, $3,000; 1 assistant for developing fisheries and for saving and use of fishery products, $2,400; 1 storekeeper, Pribilof Islands, $1,800; 1 clerk, $1,200 (in lieu of $900); 1 foreman, Bozeman station, $1,200; 1 foreman, Clackamas station, $1,200; 1 superintendent, Key West biological station, $1,800 (in lieu of $1,500); 1 apprentice fish-culturist, Springville station, $600. *Miscellaneous expenses:* Administration $10,000; propagation of food fishes, $400,000 (increase of $25,000); maintenance of vessels, $95,000 (increase of $5,000); inquiry respecting food fishes, $50,000; statistical inquiry, $7,500; Alaska general service, $100,000; protecting sponge fisheries, $3,000. *Special items:* Berkshire trout hatchery, for increasing hatching and rearing facilities, including construction and repair of ponds, improvements to water supply, and for equipment, $2,500; St. Johnsbury station, for establishment of an auxiliary station on Lake Champlain, $5,000; Pribilof Islands, for purchase or construction of power lighter, $20,000.

The Civil Service Commission announces that there are many openings for women as ship draftsmen in the Navy Department at Washington and in navy-yard service throughout the United States. Applications will be received and papers examined at any time, and the applicants who qualify will be offered immediate employment. The pay ranges from $4 to $6.88 per day. The commission lists a total of 13 acceptable forms of training and experience for the four grades into which the register of eligibles will be divided. The applicant may offer either "at least two years' experience in a drafting room, engaged on work of developing plans for buildings or structures involving steel work, architectural work, or mechanical drafting work, or graduation from a course in architecture or mechanical or structural engineering at a college or university of recognized standing" or "graduation from a technical school or college of recognized standing supplemented by a certificate that the applicant has satisfactorily taken and passed a short course in naval architecture

conducted by an institution of learning, one whose regular course is naval architecture and whose special short course in naval architecture referred to above shall have been approved by the commission." The other minimum requirements all include experience in shipbuilding.

The London *Times*, in recording the centenary of the British Institution of Civil Engineers writes: The Institution of Civil Engineers, our premier engineering society and the parent of several other institutions of rather more specialized character, celebrates the centenary of its foundation. It was on January 2, 1818, that it was established by eight young men, who met for that purpose in the Kendal Coffee-house in Fleet Street. It was fortunate in securing as its president, two years after its birth, Thomas Telford, the foremost engineer of his day and one of the leading engineers of all time. Although he was not present at the inaugural meeting, he may fairly be ranked as its founder. Holding the office until his death in 1834, he devoted much of his time during his life to furthering its interests, and at his death bequeathed a sum of money for the establishment of the Telford Medals and Premiums, which have ever since served to encourage the presentation of original communications at its meetings. It was in his time also, in 1828, that its position was established by the grant of a Royal Charter, which contains the famous definition of civil engineering as being:

> The art of directing the Great Sources of Power in Nature for the use and convenience of men, as the means of production and of traffic in states both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation and docks, for internal intercourse and exchange, and in the construction of ports, harbors, moles, breakwaters and lighthouses, and in the art of navigation by artificial power for the purposes of commerce, and in the construction and adaptation of machinery, and in the drainage of cities and towns.

It is announced from Ottawa that the minister of naval service, controlling fisheries, has decided to close some fourteen lobster hatcheries scattered about the coasts of the Maritime Provinces. The question of lobster hatching has been a subejct of investigation for the past four years. Arrangements are being made to start an educational campaign among the fishermen to induce them to protect all berried lobsters and to cooperate with the department in protecting the fishery and saving the lobster industry.

UNIVERSITY AND EDUCATIONAL NEWS

New York University is endeavoring to raise a fund to meet the emergency war conditions and subscriptions have been received amounting to over $250,000, $94,000 from the alumni of the school of applied science and liberal arts, $89,000 from the professional schools and $67,000 from the undergraduate body on $25 subscription payroll over a period of five years at $5 per year. Part of the plan is to secure an endowment of $500,000 for the engineering school in connection with a cooperative plan of education between the industries and the university. Mr. Mois H. Avram, lecturer on industrial engineering in the university, has been active in this work.

Excavation was started on July 18 for the foundation of the additional building to the University of Nebraska Medical School, Omaha, to be erected at a cost of $150,000. The new building will be four stories in height, red brick and will house the laboratories of pharmacology, physiology and biologic chemistry.

The Secretary of State for the Royal Air Force of Great Britain announces that the sum of £25,000 has been placed at the disposal of the government by Sir Basil Zaharoff, for the purpose of endowing a professorship of aviation. This donation is in continuation of donations previously made by Sir Basil for the foundation of chairs of aviation at the universities of Paris and Petrograd, in order to assist in the progress of aviation among the allies, and it is hoped that the occupants of the chairs will continuously exchange views. It is proposed that the professorship shall be called the Zaharoff professorship of aviation. and that it shall be a professorship of the Uni-

versity of London attached to the Imperial College of Science and Technology.

DUE to the absence of Dean Vaughan in war service, a reorganization of the administration staff of the University of Michigan Medical School has been necessary. The present officers are as follows: dean, Victor C. Vaughan, M.D., LL.D., Colonel, M. C., N. A. (absent on leave); assistant dean, Charles W. Edmunds, A.B., M.D.; acting secretary, Rollo E. McCotter, M.D., and assistant secretary, Ethel Bradley Flick.

THE following new appointments have been made in the various departments of Western Reserve University. In Adelbert College, Webster Godman Simon, A.M., as instructor in mathematics. In the School of Medicine, Carl J. Wiggers, M.D., as professor of physiology. The following promotions have been made in the Dental School: Harold Newton Cole, Ph.D., M.D., assistant professor of dermatology and syphilology; Gaius Elijah Harmon, M.D., C.P.H., assistant professor of hygiene and bacteriology (now senior instructor in hygiene); Bradley Merrill Patten, A.M., Ph.D., assistant professor of sistology and embryology.

IN the Georgetown University Medical School Dr. Clarence R. Dufour, who resigned as clinical professor of diseases of eye and ear, has been appointed emeritus professor; Dr. Isaac S. Stone, professor of gynecology, who resigned after twenty-six years of service, has been succeeded by Dr. J. Thomas Kelly, and Drs. James M. Moser and John A. Foote have been appointed assistant professor of pediatrics.

DR. R. O. CROMWELL, formerly assistant plant pathologist at the experiment station at West Raleigh, North Carolina, has been appointed extension plant pathologist at the Iowa State College of Agriculture and Mechanic Arts, at Ames Iowa.

DR. SAMUEL T. DARLING, of the International Health Board, has been appointed professor of hygiene and director of laboratories in the School of Medicine and Surgery in São Paulo, Brazil.

DISCUSSION AND CORRESPONDENCE

THE CRITERION OF SUBSPECIFIC INTERGRADATION IN VERTEBRATE ZOOLOGY

INTERGRADATION is now generally accepted, both in codes of nomenclature and in practise, as the criterion of zoological subspecies. A second means of determining subspecific relationship, the degree of difference, so strongly advocated by Dr. C. Hart Merriam[1] and others, has been found unsatisfactory; still more so a third, the natural outgrowth of the latter, that of general resemblance, which makes the species practically equal to a subgeneric group. Dr. Ernst Hartert and a few others have employed this last method, but it leads to such evident inaccuracies as treating the American cedar waxwing, *Bombycilla cedrorum*, as a subspecies of the Bohemian waxwing, *Bombycilla garrula*.

What constitutes subspecific intergradation, however, seems still to be debatable, if the diversity of usage among current authors is to be taken as evidence. Briefly stated, there are three ways in which intergradation takes place: (1) By a gradual change over contiguous geographic areas; (2) by an abrupt change in an intermediate area; and (3) by individual variation, whether or not the ranges of the two forms adjoin. The first of these is the kind of intergradation so commonly seen on continental areas where one form passes insensibly into another in the intermediate territory, and is so well-known as not to need illustration. The second is much less common and often results in the presence at certain localities of typical examples of both forms, together with all shades of intermediates; but the only question likely to arise in treating a case of this kind is the allocation of the individuals which occur in such places,—whether they shall be treated all as the one form to which they collectively most approach, or whether the more or less typical examples of each shall be referred to their respective races. The third kind of intergradation, that of individual variation, is of almost as frequent occurrence as

[1] SCIENCE, N. S., V., No. 124, May 14, 1897, pp. 753–758.

the first, and is the sort so often seen on islands, on mountain peaks or other isolated continental areas; and it is this that seems to be at present the debatable kind of intergradation. Shall this be considered equivalent to uninterrupted continental intergradation, or shall it be ignored entirely as intergradation, and the forms so limited be considered distinct species, although some of their individuals may not be distinguishable from those of some other form?

The recent remarks of Mr. H. S. Swarth on the subspecific relationships of certain jays of the genus *Aphelocoma*[2] again brings up this question. A statement of this particular case, which the present writer has already briefly explained,[3] may be of interest in the present connection, since it is typical of the third kind of intergradation. *Aphelocoma californica californica, Aphelocoma californica immanis,* and *Aphelocoma californica hypoleuca* are three jays occurring on the Pacific coast from Oregon to southern Lower California, the first two with continuous ranges, the third supposedly isolated. Adjoining *Aphelocoma californica immanis* on the eastern side of the Sierra Nevada, and living sometimes at the same localities, where apparently specifically distinct, is *Aphelocoma californica woodhouseii.* The last, however, ranges eastward to Texas, where it intergrades with *Aphelocoma californica texana,* and through other Mexican subspecies with *Aphelocoma californica sumichrasti* of southern Mexico, the range of which is entirely separate and far removed from any of the races of California or Lower California. Some individuals of *Aphelocoma californica sumichrasti,* however, are difficult, if not impossible, certainly to distinguish from *Aphelocoma californica immanis* or *Aphelocoma californica hypoleuca.*

Mr. Swarth would consider that the individual variation of *Aphelocoma californica sumichrasti* from southern Mexico, which bridges the difference between *Aphelocoma californica immanis* and *Aphelocoma californica hypoleuca,* is not intergradation in a subspecific sense; furthermore, he regards *Aphelocoma californica hypoleuca* from southern Lower California as a distinct species (although he admits that certain examples of *Aphelocoma californica immanis* found in northern California are indistinguishable from this Lower California form) because of the interposition of a darker form of *Aphelocoma californica,* the range of which he considers widely removed, and with which he supposes *Aphelocoma californica hypoleuca* does not geographically intergrade.[4] In such cases the intervening form has the same biological effect as a land or water barrier. Thus the particular point brought out is that intergradation by individual variation is not intergradation in a subspecific sense, and that, therefore, a form to be a subspecies must have a continuous range and merge geographically. With this as the only criterion, all island and isolated alpine forms must be considered distinct species, however slightly and inconstantly they may be differentiated, a view by no means held by zoologists generally.

The principle underlying the use of intergradation as an indication of subspecific relationship and sought to be expressed in nomenclature by a trinomial is that a subspecies is an imperfectly segregated species. Manifestly no form that is a geographic representative of a species is perfectly segregated if any of its normally adult individuals are practically indistinguishable from comparable individuals of another form. We should, therefore, make our nomenclature conform to the facts, not our facts to the nomenclature. In order to do this and satisfactorily to settle the specific status of a number of closely related forms that collectively cover a large geographic area, it is important that we take not only one or two contiguous, but all the forms and their

[2] *Univ. Calif. Publ. Zool.,* XVII., No. 13, February 23, 1918, pp. 406–413; 420–421.

[3] *Condor,* XIX., May, 1917, p. 94.

[4] That *Aphelocoma californica hypoleuca,* as we shall elsewhere explain, proves to have a range practically continuous with *Aphelocoma californica californica* and completely intergrades geographically with the latter, does not affect the principle at present involved.

relations, into consideration. It is evident to any zoologist who has studied large series of specimens of a wide-ranging and plastic species that it is, of course, easy to mistake false for true intergradation, as, for instance, if adults in comparable age and condition are not used in comparison. It is likewise easy to overlook evidence of intergradation, since the latter is sometimes obscured by other circumstances. For example, two forms may meet on the edges of their ranges and intermingle on common ground, remaining perfectly separate and be apparently distinct species, yet elsewhere directly or indirectly through other forms completely intergrade. This is exemplified in our case of *Aphelocoma* by *Aphelocoma californica woodhouseii,* which remains an apparently distinct species where its range meets that of *Aphelocoma californica immanis* at the foot of the Sierra Nevada, but which eastward passes directly by continuous geographic intergradation into *Aphelocoma californica texana,* and thence through forms in eastern Mexico into *Aphelocoma californica sumichrasti,* which in turn intergrades individually with *Aphelocoma californica hypoleuca* and *Aphelocoma californica immanis.* A parallel case is found in the mice of the genus *Peromyscus,* as shown by Mr. W. H. Osgood,[5] in *Peromyscus maniculatus austerus* (Baird) and *Peromyscus maniculatus oreas* Bangs; and also in *Peromyscus maniculatus gambelii* (Baird) and *Peromyscus maniculatus rubidus* Osgood. To consider them species, because at some point where their ranges meet they remain distinct while at another similar place they intergrade, would clearly not best represent the facts.

The use, therefore, of individual variation as one of the chief criterions of intergradation seems not only not illogical but necessary.

HARRY C. OBERHOLSER

COTTON AS A SEED CROP

UTILIZATION of cotton seed as a source of oil and other valuable products has brought forward two questions for cotton breeders; first, the possibility of increasing the oil-content in the seeds of lint-bearing varieties; and second, the breeding of a lintless cotton, to be grown strictly as a seed-crop. In asking the first question it is assumed that the oil might be increased without reducing the lint, while the second is prompted by the idea that lintless varieties could be harvested by machinery, thus avoiding the chief difficulty and expense in the production of fiber, the labor of picking the cotton by hand.

Increasing the oil in cotton seed was undertaken several years ago in connection with the breeding of the Trice variety. A large amount of careful work was done by Professor S. M. Bain, of the University of Tennessee, assisted by the late Mr. Albert T. Anders, formerly of the Bureau of Plant Industry, but without finding the definite differences that were sought as the basis of selection for oil-content. The fluctuations induced by conditions of growth or associated with various degrees of maturity attained by the seeds were so large as to conceal inherent differences of individual plants or progenies. As might be expected from the greater proportion of kernel to shell, the oil-content seems to be higher in varieties with large seeds, more than 24 per cent. of oil, or 64 gallons per ton of seed, being reported for the Meade cotton in Georgia, but large-seeded varieties are unpopular because they do not have the highest percentages of lint.

The breeding of lintless varieties might not prove difficult, since individual plants with entirely naked seeds have been found as chance variations in lint-bearing stocks. Degenerate "slick-seeded" plants with little or no fuzz on the seeds and only a sparse covering of lint are of rather common occurrence in the Southeastern States in ordinary short staple fields raised from "gin-run" seed. Some of the inferior "Hindi" variations of the Egyptian type of cotton have nearly naked seeds. Failure to eliminate the Hindi admixture in Egypt damages the crop to the extent of several million dollars every year. A lintless cotton would need to be excluded rigorously from any region where other varieties are grown. The seed must become much more valuable than

[5] *North Amer. Fauna,* No. 28, April 17, 1909, pp. 52, 53, 66, 69 and 70.

it even now is before overtaking the value of the lint, especially in long staple varieties. No compensating increase in the yield of seed is to be expected from a lintless cotton, the fiber being merely cellulose, like the woody tissues of the plant.

Picking a lintless cotton by hand would be out of the question because the seeds fall out as soon as the bolls open, but possibilities of avoiding this difficulty have been suggested by the fact that all varieties do not open the bolls to the same extent or with equal readiness. Certain foreign cottons have nearly indehiscent capsules, as have some of the relatives of cotton, including the okra plant, which could be grown as a seed crop. Other factors that affect the opening of cotton bolls are heat and dryness. Full-grown bolls of Kekchi cotton remained fresh and apparently unchanged for nearly six months in a greenhouse experiment, and yet opened normally when the plants were taken outside and allowed to dry. The failure of bolls to open in cool autumn weather, which now appears as a danger or limiting factor of cotton culture in some parts of California, might be an advantage if harvesting by machinery were practicable.

In considering the possibility of utilizing late-opening cotton in California it seemed that two kinds of machines would be needed. The first machine might be thought of as a modified corn-binder that would cut or pull the plants, and at the same time press and tie them into loose bundles or small bales, not too large to be handled easily nor too dense to dry without rotting. The bundles could be kept rather narrow, since the form of the plants can be controlled by methods of spacing and thinning that have been worked out. The stalks would be in the middle of the bundle, while most of the bolls would be on the outside, so that gradual drying and normal opening might be expected.

As the plants would be pressed flat in the bundles they should come out in convenient shape for running into another machine for picking the seed cotton from the bolls. Relatively slight adaptations of existing types of picking machinery might serve, the problem in this form being much simpler than that of picking cotton from live plants in the field, which many inventors have attempted to solve. Gumming of the machinery and staining of the fiber with the plant juices would be avoided, as well as the difficulties of operating and repairing very complicated machines in the field.

That machine picking could produce grades equal to those of cotton picked carefully by hand is hardly to be expected, although the quality might not be seriously impaired, if admixture with weak, immature fiber can be avoided. This might be possible in parts of California where the bolls are not likely to be frozen, though the leaves may be killed.

Cleaners and gins could be operated in connection with stationary picking machines, and utilization of the stalks for paper-making or other industrial purposes would become more feasible. Leaving the fields clear at the end of the season would facilitate the planting of other crops, and might have advantages in relation to pests or diseases. Even with cotton considered as a seed-crop, the possibilities of mechanical harvesting do not appear to depend upon the breeding of lintless varieties. Special characters, conditions, or appliances that might be expected to facilitate the harvesting of lintless cotton seem likely to be more useful in connection with lint-bearing varieties.

O. F. Cook

Bureau of Plant Industry,
U. S. Department of Agriculture

AN ASPECT OF THE RELATION BETWEEN ABUNDANCE, MIGRATION AND RANGE IN BIRDS

The steps by which a species of bird extends its range or acquires specialized migratory habits are not known. They present problems of interest in themselves and wide bearing in other fields. The aspect of the matter here set down is at least worthy of consideration.

The red-breasted nuthatch is a bird which breeds in the northern coniferous forests. Some years it sweeps south across the country in fall in considerable numbers, and it is ex-

ceptional when some are not to be found in fall and winter in favorable localities in our latitude. A comparatively small number are seen returning the following spring, often accompanying flocks of north-bound warblers. This past season is remarkable in that practically none came south. Two circumstances that have come to my attention have a significant bearing on this fact. In late winter at a locality on Long Island where the species can generally be found and it was absent, chickadees were observed feeding on pine seeds, one of the nuthatch's favorite foods, showing that it would have fared well had it been present. Also, in the preceding summer, observers who visited the southern edge of its breeding range found it unusually scarce.

We may place the movement of the red-breasted nuthatch with what I shall call centrifugal migrations. Species which possess such, of which there are a number of good examples, periodically attain a great abundance in their permanent range, and then sweep outward, as it were in waves. For purposes of discussion I will mention three other types of birds. The white-breasted nuthatch which occupies a broad area to the south of its red-breasted cousin, has, so far as is apparent, no migration. The song sparrow, although always present over a large part of its range, has a very definite intraspecific migration, and many species have what I shall call a centripetal migration, that is, they return from the distant south to breed each year in a definite northern area usually unsuitable to their permanent occupancy.

The centrifugal type of migration is notable for two things, its futility and its wastefulness. By futility I mean that species do not seem to increase their permanent range by that method; rather, periods of abundance and migration are followed by periods of scarcity even in that range. Data enough has been gathered to at least partially explain this. Individuals swept south by the wave seem not to have the definite migration instinct which causes centripetal migrants to return to their identical nesting localities over zones of latitude. One or more instances are at hand of the red-breasted nuthatch remaining to breed in southeastern Massachusetts where (in the Cape Cod region) it becomes especially numerous during its incursions, perhaps from the abundance of its favorite pine seeds. Yet it is probably too much of a wanderer ever to establish a permanent colony there, even if the environment were satisfactory. Probably the majority of any wave of centrifugal migrants is utterly dissipated and lost, and a small minority find their way back to their permanent range. In fact there is little to be said in favor of centrifugal migration except that it is expedient, in fact the exigencies of the case may demand it.

I will now enter a little further into the realms of hypothesis and present the most plausible view of the sequence of migrations. The centrifugal condition is the original one, with the species in a state of unstable abundance, followed by the elimination of centrifugal migrants and the permanent resident condition typified by the white-breasted nuthatch, where the species is sufficiently adjusted to conditions to maintain itself in unvarying though comparatively small numbers. The migratory tendency now begins to express itself in a definite way among the individuals, many of which have definite breeding and winter localities, the former perhaps (in the case of the song sparrow) in some garden, the latter in some swamp. The tendency is for these two localities to become separated by greater and greater distances of latitude until we have a well-marked intraspecific migration.

As this process goes forward the range of a species may well break in the middle, leaving a centripetal migration in which highly developed homing instincts in the individual bird take the place of the futile centrifugal "wanderlust" of the race in its initial condition. The maximum ability to colonize and expand would come with the stage in which the individual had a definite migratory instinct to adjust to the season and yet was sufficiently a permanent resident to "hang on" in a good locality against adverse circumstances, a condition to my mind approximated among familiar species by the song sparrow, which has at

this time considerable abundance over an unusually extensive range. Also birds with the greatest development of centripetal migration, though often exceedingly abundant, are perhaps less resistant than others. Of the shore birds which formerly thronged our coast, the greater yellowlegs, whose summer and winter ranges were not so widely separated, has held out best against the inroads of gunners, while the Eskimo curlew and golden plover with the longest migration routes, have suffered most severely.

The above aspect of the situation may be of interest to the student of fluctuating population and political complications arising therefrom as well as to the student of bird migration. The fact seems to be that in nature a species adjusted to maintain its numbers constant even though comparatively small, is in a more advantageous position than one in which there is a rapid increase of numbers necessitating migrations beyond the capabilities of the individuals.

J. T. Nichols

New York City

QUOTATIONS

THE ROCKEFELLER FOUNDATION

The Rockefeller Foundation in New York is a conspicuous example of modern philanthropic effort. Owing its existence and its maintenance to the enlightened liberality of Mr. John D. Rockefeller, it is conducted on business lines without the appeals to public benevolence which, in the absence of state endowment, are generally necessary to procure the funds required for the successful prosecution of charitable enterprises. A review of the work done by the foundation in 1917 for various purposes connected with the war, and in regard to public health and medical education, recently issued by the president, Mr. George E. Vincent (New York, 1918) states that at the end of 1917 the principal fund had a market value of about £21,000,000; the income of that fund for the year was £1,430,770. To this were added a balance carried over from 1916, a gift by Mr. Rockefeller of £1,100,000, and the sum of £1,000,000 voted by the trustees from the principal fund. The cash balance carried forward into the year 1918 was £23,325,809, but all except £254,267 of this amount will be needed to meet appropriations and pledges for the next fiscal year. The foundation is at present devoting by far the greater part of its available resources to the support of war work. When the United States joined in the great struggle the foundation placed a large sum at the disposal of the American Red Cross, which has undertaken comprehensive schemes of relief for the allied armies and the civilian population of the invaded countries. The only work which it is now directly administering in Europe is an antituberculosis campaign in France. The American government from the first insisted that the training camps were to be regarded as educational institutions. Official commissions and national and local societies worked together in providing within and outside camps comfort, recreation, social entertainment, educational opportunities, and moral safeguards for the troops. To nearly all the units that make up this vast cooperation the foundation has given sums amounting in the aggregate to £900,000. In 1917 a portable military base hospital was erected in the grounds of the Rockefeller Institute for Medical Research, embodying the features which British and French experience has proved to be essential. In this hospital the Carrel-Dakin method of sterilizing wounds is being demonstrated. To the hospital and the laboratories medical officers of the army and navy are being sent for study and experience. The foundation has undertaken the making of serums and their distribution to government hospitals. Funds are being provided to help the Surgeon-General in engaging specialists for the treatment and hospital care of nervous and mental diseases due to the war. Contributions were also made for the after-care of the victims of infantile paralysis in the epidemic in New York in 1916. In 1915 the foundation offered to bear the cost of establishing and maintaining as a part of Johns Hopkins Hospital a school of hygiene and public health. During 1917–18 a staff was recruited and lines of work laid down. Dr. William H. Welch resigned

his professorship in Johns Hopkins to become director of the new institution. During 1917 steady progress was made in campaigns against hookworm, malaria and yellow fever, in promoting better health administration, in securing reform in sanitary legislation, in persuading governments to increase their expenditure for preventive medicine, and in encouraging public health education. In China the foundation is promoting modern medical education and hospital administration. In September last the Chinese Minister of Education laid the corner stone of the Peking Union Medical College, which is being built in the Chinese capital. The program also includes a medical school and hospital at Shanghai, but the war has interrupted the prosecution of this scheme. The growth of the Rockefeller Institute for Medical Research has called for increasing sums for equipment and current expenses, and £400,000 was appropriated during 1917 as an addition to its endowment.—*British Medical Journal.*

SCIENTIFIC BOOKS

Fresh-water Biology. By HENRY BALDWIN WARD and GEORGE CHANDLER WHIPPLE, with the collaboration of a staff of specialists. New York, John Wiley & Sons. 1918. 8vo. 1111 pp., 1547 figures in text.

At last American students of fresh-water life are provided with a handbook and guide that will enable them to acquaint themselves with the forms of life found in their native lakes, ponds and streams. Ward and Whipple are the editors, and they themselves contribute five of the thirty-one chapters. Ward writes the general introduction and two chapters on parasitic worms, and one on Gasterotricha, and Whipple writes the concluding chapter on Technical and Sanitary Problems. There are two further introductory chapters, one by Shelford on conditions of existence, and an altogether excellent and practical chapter by Reighard on methods of collecting and photographing. The remaining chapters discuss the principal groups of aquatic organisms and are written by well-known American specialists in the several groups. All are prepared with evident care and with due regard for the needs of the general student and all are adequately illustrated.

Three of these chapters are for reading purposes only—the ones on bacteria by Jordan, on the higher plants by Pond and on aquatic vertebrates by Eigenmann. These are excellent summarized statements of the chief biological phenomena of these groups and are most interesting reading.

The volume is much more than a text-book for the remaining groups (to which 26 chapters are devoted): it is a handbook and guide. and a means of identification, and this is its peculiar merit. Each chapter gives, besides an introductory account of the group, an illustrated key, that is adequate for the determination of the forms and that is convenient and workable. No such set of keys has hitherto been available anywhere. The clear and copious illustrations are placed alongside the reading matter relating to them in the text, and are adequate for the interpretation of the characters used.

This book will at once take its place as the most indispensable reference work for students of freshwater biology; and it is likely to hold that place for a long time.

JAMES G. NEEDHAM

Equidæ of the Oligocene, Miocene and Pliocene of North America. By HENRY FAIRFIELD OSBORN. Memoirs of the American Museum of Natural History, Volume II., Part I., issued June 10, 1918.

AN extensive memoir of two hundred and seventeen quarto pages, illustrated by one hundred and seventy-three figures, and fifty-four plates reviews our knowledge, from a systematic standpoint, of the "Equidæ of the Oligocene, Miocene and Pliocene of North America."

The present revision of the fossil horses "is *iconographic* in the sense that all the original type figures of authors are reproduced in *facsimile,* and all unfigured types, especially those of Marsh, are now figured for the first time. . . ." The work is based largely on the collections at Yale and at the American Mu-

seum of Natural History, but a use was also made of type material in other collections.

Osborn's idea in presenting the matter in this form is that "the permanent data of systematic paleontology are the *type specimens,* determinate or indeterminate, the *type locality,* the *type geologic level.* Descriptions, figures, opinions, inferences, phylogenetic and other speculations are subject always to the fallibility of human observation and interpretation." These ideas of course are fundamental and apply to other phases of paleontology than the systematic portion.

A full discussion of the "Genesis and Evolution of Single Dental Characters" is given with abundant illustrations. This is followed by a review of "Geologic Horizons and Life Zones" appropriately illustrated with maps and tables.

The systematic portion discusses one hundred and forty-six species distributed among ten genera. Each species is carefully discussed and the type material illustrated. On turning the pages one is struck by the fragmentary nature of many of the species—but this is the condition throughout all fossil vertebrate groups. To some of the species more information has been added since their description but many of them stand to-day as they were originally described. Many species are known from very complete material.

The contribution is one of which American paleontologists may well be proud. Its permanent character is the careful collection and assembling of data on all species of fossil horses known from the Oligocene to the Pliocene of North America. The magnitude of the task is almost appalling in the amount of detailed work involved. The author tells us that this is a portion of the work done in connection with his "Monograph of the Equidæ" on which he has been working for the last eighteen years. A portion of the present work is due to the collaboration of Dr. W. D. Matthew to whom the author gives full credit.

The high standard assumed by the publications of the American Museum of Natural History twenty-five years ago is maintained in the present memoir. The typography and illustrations are excellent.

Roy L. Moodie
College of Medicine,
University of Illinois

SPECIAL ARTICLES

NOTE ON MEASURING THE RELATIVE RATES OF LIFE PROCESSES

The development of quantitative methods in biology depends largely on finding means of measuring the speed of life processes. In most cases the absolute rate is of less importance than the relative rate (*e. g.,* the normal velocity compared with that observed under the influence of a reagent). Examination of the literature shows that the determination of relative rates is frequently made in a faulty manner, which could easily be avoided by a slight change of method.

We may illustrate this by supposing that the life process in question is a chemical one. The rate of a chemical reaction is expressed by its velocity constant. The simplest case is that in which a single substance, A, decomposes. The usual equation is[1]

$$K = \frac{1}{T} \log \left[\frac{A}{A - X} \right],$$

in which K is the velocity constant, T is time and $A - X$ is the amount remaining at any given time, T.

When the reaction is half completed the value of $A \div (A - X)$ is always 2, no matter what the original concentration of A. The time required to reach this stage of the reaction is inversely proportional to the value of K: for it is evident that if we double the value of K we must halve the value of T, provided the value of $A \div (A - X)$ remains 2, or any other constant value. Hence we see that no matter what stage of the reaction we choose (half completed, one fourth completed, etc.) the velocity constants are inversely pro-

[1] Natural logarithms give the true value of k, but common logarithms are frequently used: these multiply the value of k by .4343. For illustrations of the application of this equation to life processes see Osterhout, W. J. V., Science, N. S., 39: 544, 1914; *Jour. of Biol. Chem.,* 21: 585, 1917; *Proc. Nat. Acad. Sciences,* 4: 85, 1918.

portional to the times required to bring the reacton to the same stage.

This holds not only for reactions of the first order (where a single substance decomposes) but for reactions of higher orders (where two or more substances combine) as well as for consecutive reactions[2] and autocatalysis.[3]

It follows that when a chemical process proceeds at different rates under different conditions, we can compare the velocity constants by simply taking the reciprocals of the times required to bring the reaction to the same stage. If we merely wish to know the relative rates (as is usually the case in biology) it is not necessary to determine the velocity constants at all.

Whenever the initial conditions are the same with respect to concentration we need only compare the times required for equal amounts of work, since these bring the reaction to the same stage.

If on the other hand one attempts to arrive at the relative rate by comparing the amounts of work performed in equal times (as is frequently done in biological research) he can easily fall into serious error. This is evident from Fig. 1, which shows the curves of a reaction proceeding at two different rates, the velocity constant of *B* being twice as great as that of *A*. It is evident that the abscissa of *A* at any point is just twice that of *B* while no such relation obtains among the ordinates.[4] For example at the point *C* the ordinate of *B* is twice as great as that of *A*, while at the point *D* it is only 1.1 times that of *B*. Hence it is evident that we should compare abscissæ rather than ordinates (*i. e.*, times required to do equal amounts of work rather than amounts of work performed in equal times).

This principle will also be found to apply to a variety of physical processes.

The principle is sufficiently obvious where successive determinations are made and curves are drawn. But there is a common type of

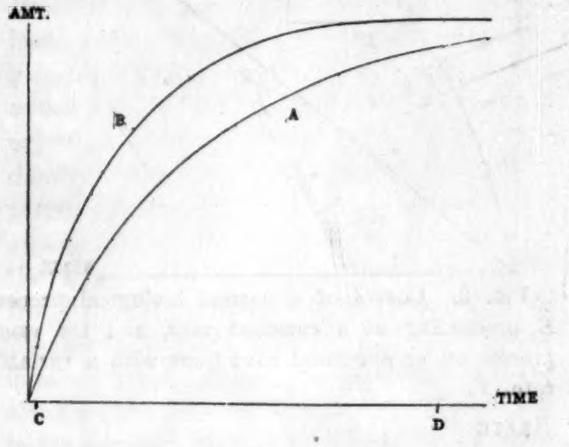

FIG. 1. Curves showing the same process proceeding at different rates one of which, *B*, is twice as rapid as the other, *A*.

experimentation in which, for various reasons, a single observation at one rate is compared with a single observation at another rate. The principle in question is then easily overlooked. In some cases this leads to serious errors.

If we wish to compare the normal rate of a biological process with an abnormal rate (*e. g.*, under the influence of a reagent) it is evident that we can use this principle, but the method of application will depend on circumstances. The normal rate may be constant and its graph a straight line. If this is also true of the abnormal rate it will make no difference whether we compare times or amounts of work.

When the abnormal rate is variable we may have the condition shown in Fig. 2. The normal rate *E* is constant: the variable abnormal rate *F* at any point such as *H* may be determined by drawing the tangent at that point and taking the ratio $J \div K$.

In many cases it is not possible to secure data for drawing directly such a curve as that shown in Fig. 2. We may, however, deter-

[2] The principle holds for consecutive reactions in case all the constants are multiplied by the same factor, otherwise not. *Cf.* Osterhout, W. J. V., *Jour. Biol. Chem.*, 32: 23, 1917

[3] *Cf.* Mellor, J. W., "Chemical Statics and Dynamics," p. 291, 1909.

[4] We can not avoid the difficulty by comparing the rates of the two processes at a given time; for the rates so obtained will bear no constant ratio to each other. Only when they are compared at the same stage of the reaction will they show a constant relation; this gives the relation between the velocity constants.

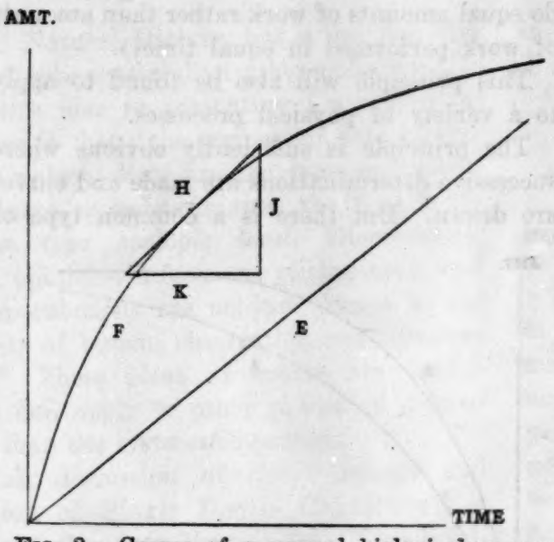

FIG. 2. Curves of a normal biological process *E* proceeding at a constant rate, and the same process under abnormal conditions with a variable rate, *F*.

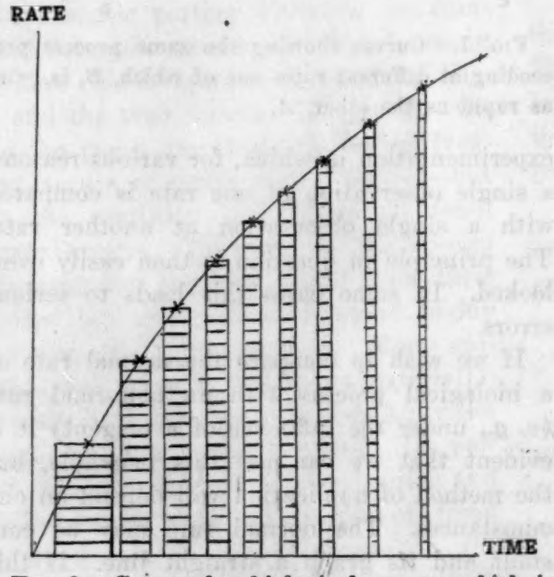

FIG. 3. Curve of a biological process which is studied by measurements of its rate made at frequent intervals. The shaded portions represent periods during which measurements are made. The unshaded portions represent intervals during which there are no measurements.

mine the rate at various periods as shown in Fig. 3, in which the periods during which the rate is measured are shaded while the intervals during which no measurements are made are unshaded.

We can determine the time necessary to perform a given amount of work and take its reciprocal as the rate: this rate is of course an average for the whole period. If the rate is changing during the period the average rate probably occurs near the middle of the period; hence we may place the ordinate representing the rate in the middle of the period as shown in the figure. The resulting curve can be transformed into a curve of the type shown in Fig. 2 by finding the total amount of work performed at any given time: this is accomplished by finding the area enclosed by the curve and the ordinate of the time chosen (since this area is the product of rate by time, it gives the amount of work performed).

Summary.—Measurements of the relative rates of biological processes are frequently made in a faulty manner which may easily be avoided by a slight change of method.

Usually it is preferable to compare the times required to perform a given amount of work (or to bring the reaction to the same stage) rather than to compare the amounts of work performed in a given time.

W. J. V. OSTERHOUT
LABORATORY OF PLANT PHYSIOLOGY,
HARVARD UNIVERSITY

HOW FOOD AND EXERCISE INCREASE OXIDATION IN THE BODY

LAVOISIER,[1] shortly after his discovery that oxygen supported combustion, showed that physical work increased oxidation in the body, thus giving rise to the energy for the work. He also found that the ingestion of food increased oxidation. Rubner[2] showed that of the food-stuffs, meat increased oxidation most, fat next, and sugar least. The present investigation was begun in an attempt to find out how physical work and the ingestion of food increase oxidation in the body.[3] We had already found that whatever increased oxidation in the body also stimulated the liver to an increased output of catalase, an enzyme

[1] Lavoisier, *Mem. de l'Acad. des Sc.*, 1780.

[2] Rubner, "Energiegesetze," 322.

[3] Burge, Neill and Ashman, *American Journal of Physiology*, Vol. XLV., No. 4, pp. 388–395, 500–506.

in the tissues possessing the property of liberating oxygen from hydrogen peroxide. Hence the conclusion was drawn that catalase is the enzyme in the body principally responsible for oxidation. Stated more specifically, the present investigation was carried out to determine if the end products of digestion of food, when absorbed from the alimentary tract and carried to the liver, stimulate this organ to an increased output of catalase, which being taken to the muscles and tissues increase oxidation, and if during exercise the liver was also stimulated to an increased output of catalase, thereby increasing oxidation in the muscles and thus furnish the energy for exercise.

The animals used were cats, rabbits and dogs. The catalase in 0.5 c.c. of the blood of the animals was determined by adding this amount of blood to hydrogen peroxide in a bottle at 22° C. and as the oxygen gas was liberated, it was conducted through a rubber tube to an inverted burette previously filled with water. After the volume of gas thus collected in ten minutes had been reduced to standard atmospheric pressure, the resulting volume was taken as a measure of the amount of catalase in the 0.5 c.c. of blood. The material was shaken at a fixed rate of one hundred and eighty double shakes per minute during the determinations. The animals were exercised in a tread-wheel seven feet in diameter and two feet wide. The food materials were carbohydrates (maltose, levulose, dextrose, lactose, honey, cane sugar, cornstarch, dextrin, wheat flour, corn meal, rice flour and fruits (oranges, lemons, apples, bananas, grapebean flour); fats (olive oil, bacon, cream, cod-liver oil, glycerine, palmitic acid and lard); fruit and rhubarb); proteins (egg, beef, beef extract, beef juice, aminoids and peptone); beverages (coffee, milk, chocolate, tea and cocoa).

The catalase of the blood of the animals was determined before as well as at fixed intervals after the introduction of the food materials. It was found that the ingestion of the simple sugars, dextrose, etc., increased the catalase of the blood very quickly and in some cases as much as 40 per cent. above the normal. The starchy foods, flour, etc., increased the catalase of the blood, but not so quickly as did the simple sugars. The quicker action of the simple sugars was attributed to the fact that these substances are absorbed immediately and taken to the liver, whereas the starchy foods had to be digested before absorption. Proof that the simple sugars increase the catalase of the blood by stimulating the digestive glands, particularly the liver, to an increased output of catalase, is offered in the following experiment. After etherizing a dog, the abdominal wall was opened and the liver exposed. A comparison was made of the amount of catalase in the blood taken directly from the liver with the amount of blood coming from the tissues, that in the blood of the jugular vein, for example. The blood in the liver or coming directly from the liver was always found to be richer in catalase by 15 to 20 per cent. than the blood taken from any other part of the body. This comparison was made in a great number of animals and is taken to mean that the liver is continually replenishing the catalase of the blood which is being continually used up in the oxidative processes of the tissues. After introducing a simple sugar, such as dextrose, into the etherized animal with its abdominal wall opened, the catalase of the blood taken from the liver was increased much more extensively and rapidly than the blood from a vein such as the jugular. This observation is interpreted to mean that after absorption the sugar was taken to the liver and stimulated this organ to an increased output of catalase. The end products of digestion of the other food-stuffs were tried in a similar manner and all these substances were found to stimulate the liver to an increased output of catalase, meat digest being most effective, fat next, and sugar least.

Of the fats both the olive oil and bacon produced a very quick and pronounced increase in the catalase of the blood, whereas the cream, lard and butter did not act so quickly, due presumably to their slower absorption from the alimentary tract. Coffee, milk, cocoa and tea did not produce an appreciable increase in catalase, while chocolate did. The

stimulating effect of chocolate was attributed to the high fat content of this beverage. Very ripe fruit increased the catalase of the blood quickly and extensively, while less ripe fruit did not. This was attributed to the fact that the very ripe fruit contained much sugar, which was quickly absorbed, taken to the liver, and stimulated this organ to an increased output of catalase, whereas the less ripe fruit contained less sugar and hence did not stimulate the liver so strongly. The meat digest increased the catalase of the blood very quickly and extensively, whereas meat, eaten as such, did not act so quickly, due presumably to the time taken for digestion. The meat extract and beef juice produced a small increase in catalase.

Dogs were used in studying the effect of moderate exercise on catalase. The animal was placed in a treadwheel and by a little coaxing was induced to run and thus turn the the wheel at a rate of about five miles per hour. The catalase in 0.5 c.c. of blood taken from the external jugular was determined before the exercise as well as at 15-minute intervals during the exercise. It was found that the effect of moderate exercise was to increase the catalase of the blood from 15 to 20 per cent. in most of the dogs used.

Domestic rabbits were used in studying the effect of strenous exercise and fatigue on catalase. The rabbits were also placed in the wheel, which was turned slowly by hand so that the direction in which the wheel was rotated could be changed to suit the direction in which the rabbit took a notion to run. A few slow turns of the wheel was sufficient to tire and fatigue the rabbit. Every precaution was taken not to abuse or injure the animal in any way. It was found that the strenuous exercise and fatigue decreased the catalase of the blood in some cases by as much as 30 per cent. and that during rest for an hour, the catalase returned to the normal amount and in fact above normal in several instances.

We had already shown that the output of catalase from the liver was increased by stimulating electrically the nerves (splanchnics) distributed to the liver. The explanation that suggested itself for the increase in catalase during moderate exercise was the stimulation of the liver over the splanchnics to an increased output of this enzyme, while the decrease in catalase during violent exercise and fatigue was due to the using up of catalase in the oxidative processes of the muscles more rapidly than it was being replenished by the liver. The increase in catalase during the periods of rest after hard exercise was attributed to the fact that the liver was putting out catalase in the blood more rapidly that it was being used up in the muscles.

According to the chemical theory as set forth by Ranke,[4] fatigue is due to the accumulation of substances, acid in nature, such as lactic acid, which inhibits or depresses the power of the muscles to contract. It is recognized that the accumulation of these acid substances is due to incomplete or defective oxidation. The decrease in catalase observed in the experiments reported in this paper is offered as the cause for the defective oxidation during hard muscular work and fatigue while the helpful effect of moderate exercise is attributed, in part at least, to the increase in catalase produced in this type of exercise.

From the experiments reported in this paper, the conclusion is drawn that food and exercise produce an increase in catalase with resulting increase in oxidation by stimulating the liver to an increased output of this enzyme.

W. E. Burge
Physiological Laboratory of the
University of Illinois

[4] Ranke, "Tetanus," Leipzig, 1865.

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